APPENDIX III

GE UltraScan CD Final Report, Revision 3, July 12, 2006, Sections 1-5. (28+cover sheet).

GE
PII Pipeline Solutions

UltraScan CD

Final Report

Project:	121,8 mi x 12" Hattisburg Station – Demopolis Station
Client:	Dixie Pipeline Company United States
Run Name:	DHD105 / DHD205
Run Date:	July / August 2005

PII Pipeline Solutions

Lorenzstr. 10
D-76297 Stutensee
Germany

CONTENTS

1. Introduction

Subject of this final report is the analysis of the in-line inspection survey of the

12" x 121,8 mi propane pipeline

from Hattisburg Station to Demopolis Station

using the 12" UltraScan CD crack inspection tool of PII Pipetronix GmbH, Germany,

commissioned by

Dixie Pipeline Company
1117 Perimeter CTR W
Atlanta
Georgia
United States

The results presented in this report are based on the inspection runs DHD105 and DHD205 carried out in July and August 2005.

The objective of this inspection was to detect and size in particular axial cracks and related crack-like defects with lengths >0.984 in and depths >0.039 in.

2. Description of the UltraScan CD Tool

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2.1 General Information on the UltraScan CD

In order to continue safe operation, pipeline operators in many countries have to prove the integrity of their lines. Increasing the lifetime of a pipeline might be severely impacted its operational safety due to the presence of various undetected damage mechanisms. Corrosion, for example, in the course of time can cause wall thinning or may even lead to crack generation and growth when combined with tensile stresses (SCC - stress corrosion cracking). Fatigue loading can also lead to crack generation especially in the heat affected zone of the longitudinal weld.

In order to avoid catastrophic pipeline failures due to such defects, it is necessary to periodically inspect pipelines – in particular older pipelines - by non-destructive inspection techniques. Normally, such inspections are performed 'in-line' using intelligent pigs. While the detection of metal loss (corrosion) with ultrasonic tools or MFL (Magnetic Flux Leakage) tools has been state-of-the-art for some years, there were no tools available in the past for the much more difficult task of crack detection.

In an effort to meet this important industry demand, PII Pipetronix GmbH has developed an ultrasonic pig for the detection and sizing of axially oriented crack-like anomalies (fatigue cracks, SCC etc.) – the UltraScan™ CD Tool. The tool has been commercially available since autumn 1994.

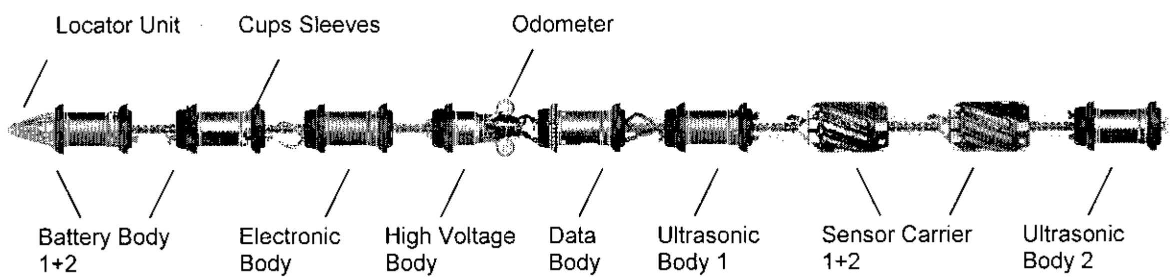
In contrast to the ultrasonic corrosion inspection, which uses longitudinal sound waves propagating perpendicularly (90°) into the pipe wall, the crack detection tool is based on a transverse sound waves inspection. This is accomplished by angling the incident longitudinal ultrasonic pulses through the liquid coupling medium (e.g. crude oil), resulting in a 45° refracted transverse sound path being generated in the pipe wall.

To date, more than 9300 mi of oil and gas pipeline have been inspected worldwide using the PII Pipetronix's proven ultrasonic technology. The experience gained so far has resulted in the UltraScan™ CD Tool being officially recognized by the German TÜV authority [1], as a government-approved substitute for in-service hydrostatic testing.

[1] Verfahrensgutachten ***Ultraschall-Rißprüfmolch "UltraScan CD" der Fa. Pipetronix GmbH,*** TÜV Rheinland, Köln. Aug. 1995.
(Report ***Ultrasonic Crack Detection Pig "UltraScan CD" of Pipetronix GmbH,*** TÜV Rheinland, Köln. Aug. 1995.)

2.2 Set-up of the Tool

The set-up of the UltraScan™ CD is shown schematically in the figure below:



12" UltraScan™ CD

At the front of the tool, a **locator unit** is mounted that emits electromagnetic signals, which are received by **TBMS** (Time Based Marker System) units placed at known aboveground marker positions. The time of the pig passage is recorded in the TBMS units. The tool contains a clock running synchronously with the TBMS clock. The time of both clocks is synchronised using GPS time. As all defect data is recorded with a current time stamp, the precise location of any detected defect with respect to the nearest marker position is ensured, hence enabling an exact location for dig sites.

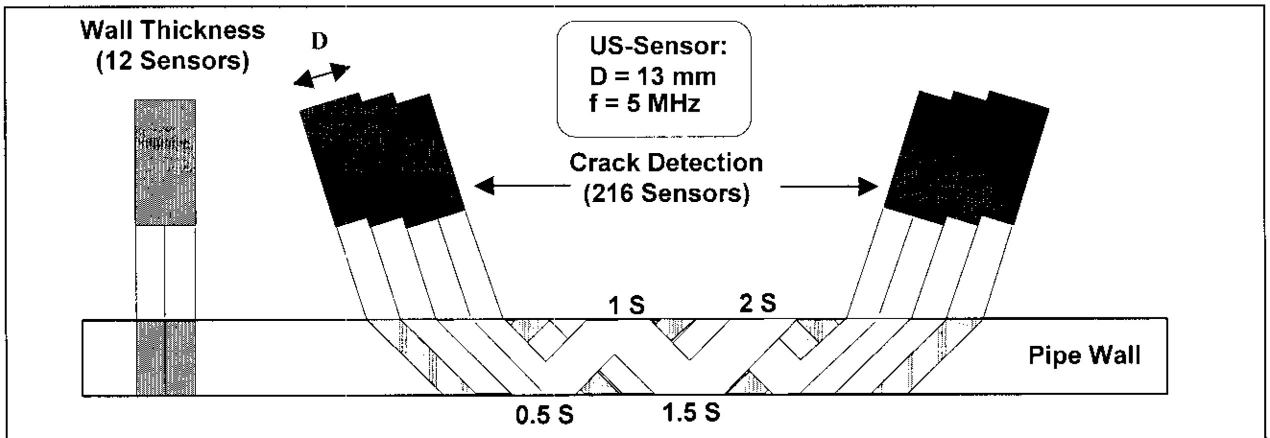
A **battery body** provides the electric power giving the tool an operational range of over 100 mi at an average speed of 4.317 ft/s.

Hard disks are used to store all the data recorded during the inspection. Two hard disks of 14,2 Gigabytes (GB) each are mounted into the electronics body thus providing a total storage capacity of 28,4 GigaBytes.

The **electronics body** contains 6 ultrasonic units. Each of them comprises 32 ultrasonic transmitters.

The **sensor carrier** of the UltraScan™ CD is designed in such a way that the entire pipe circumference is fully inspected. For 12" pipe diameters, 228 sensors mounted on 2x6 flexible skids are used for crack detection with 108 sensors inspecting in clockwise and 108 in counterclockwise direction (see figure next page). This design ensures that specified defects are detected by several sensors giving the system an inherent redundancy which is most important for reliable feature classification. Additionally, 0-1 perpendicular sensors at each skid are used for wall thickness and stand-off measurement enabling a precise projection of the crack detection data as well as reliable girth weld detection for generating the pipebook.

The sensors are arranged on a specially developed, highly flexible sensor carrier made of polyurethane which ensures that the stand-off and the transmission angle of the sensors are maintained during the inspection.



12" UltraScan™ CD Sensor Arrangement

2.3 Technical Data of the 12" Tool

General Data

• Number of bodies	7+2
• Total length	approx. 20.6 ft
• Inspection speed for full axial resolution (above 4.32 ft/s the axial resolution decreases)	up to 4.32 ft/s
• Minimum bend radius	3D
• Inspection range at 4.32 ft/s (larger range possible by using modified battery unit)	approx. 100 mi
• Flight recorder for monitoring system performance	
• Time Based Marker System for feature localisation	
• Pendulum for measuring pig rotation	

Ultrasonic Technique

• Crack detection using the 45° shear waves technique	
• Wall thickness measurement using 0° compression waves	
• Sensor distance in circumferential direction	approx. 0.28 in
• Axial resolution	approx. 0.12 in
• Minimum defect length (individual reflectors)	≥ 0.98 in
• Minimum defect depth (defect depth of reference notch)	≥ 0.04 in
• Feature localisation (with respect to next girth weld)	± 3.94 in

Ultrasonic Electronics

• Number of ultrasonic transmitting/receiving units	6
• Number of ultrasonic channels per unit	32
• Max. repetition frequency per channel	440 Hz

Data Recording

• Number of data reduction/compression computers	8-14"
• Number of hard disks	2
• Maximum data storage capacity	14.4 GB

Sensor Carrier

• Number of skids equipped	2x9
• Number of crack detection sensors per skid	10
• Number of wall thickness sensors per skid	0-1

Sensors

• Ultrasonic frequency	5 MHz
• Diameter	0.51 in
• Stand-off	approx. 0.87 in
• Number of clockwise crack detection sensors	108
• Number of counterclockwise crack detection sensors	108
• Number of wall thickness sensors	12

3. Survey Procedures

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3.1 Pipeline Preparation

Before performing the UltraScan CD run, cleaning pigs were run in order to ensure that the ultrasonic inspection would not be disturbed by wax, deposits, gravel etc. Based on the information provided by the client, it was evident that the pipeline was free and clear for the passage of the UltraScan CD tool.

3.2 Tool Preparation

At the PII Pipetronix GmbH premises in Karlsruhe, all 228 measuring channels and sensors were checked by means of a special calibration device. The ultrasonic properties of the specific medium (propane) from the pipeline were determined and the tool was programmed considering the specific conditions of this pipeline. Prior to launching, a final system check of the tool was performed on site and the tool was activated.

3.3 Inspection Run

The UltraScan CD inspection job consisted of the following pig run:

pig run name	pig departure dd.mm.yy, hh:mm	pig arrival dd.mm.yy, hh:mm	average pig speed	Comment
DHD105	29.06.05, 09:36	01.07.05, 11:00	Approx. 3.61 ft/s	
DHD205	02.08.05, 10:15	04.08.05, 09:15	Approx. 3.93 ft/s	

During the starting and receiving procedures the current position of the tool was monitored by the PII Pipetronix crew using the pig locator system.

The medium used for the UltraScan pig run was propane.

Along the pipeline route, several markers were set using the Pig Trip Boxes of the Time-Based Marker System (refer to the Marker List in Appendix D for details).

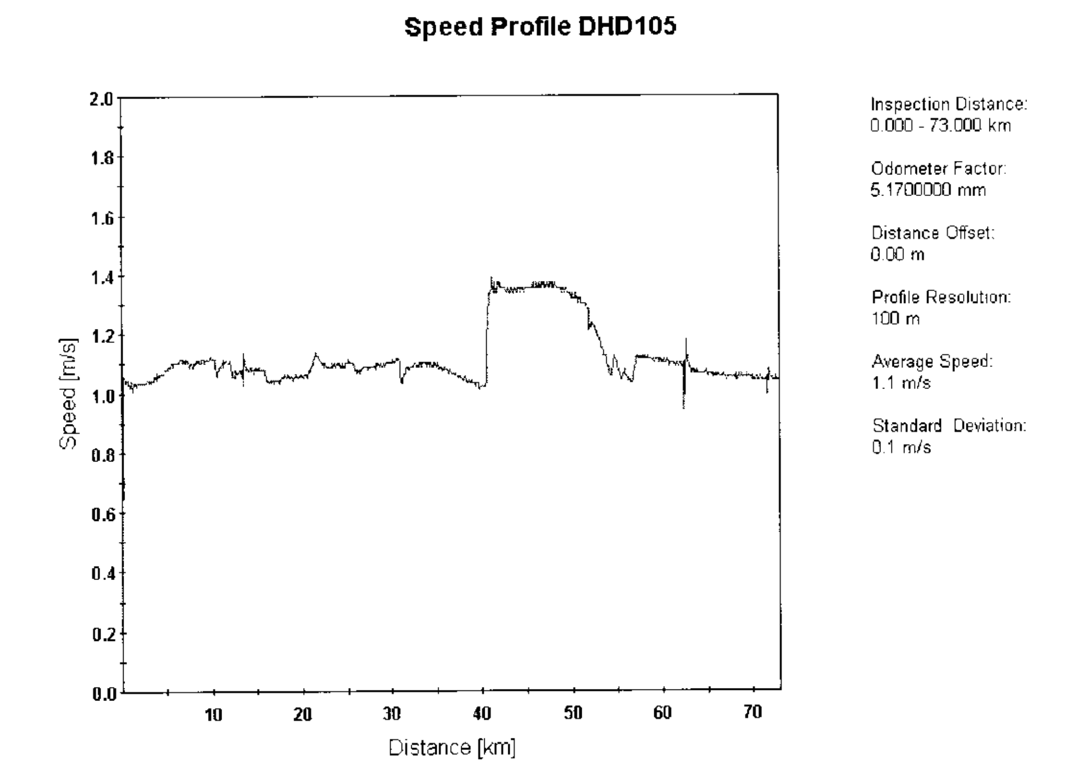
3.4 Follow-up Activities

After having received the tool, it was first checked for damage, wax deposits etc. and coarsely cleaned.

After the inspection run the data were retrieved from the hard disks. Backup copies of the collected data were made and the quality of the data was assessed. It turned out that the tool had worked properly and that the data quality was good.

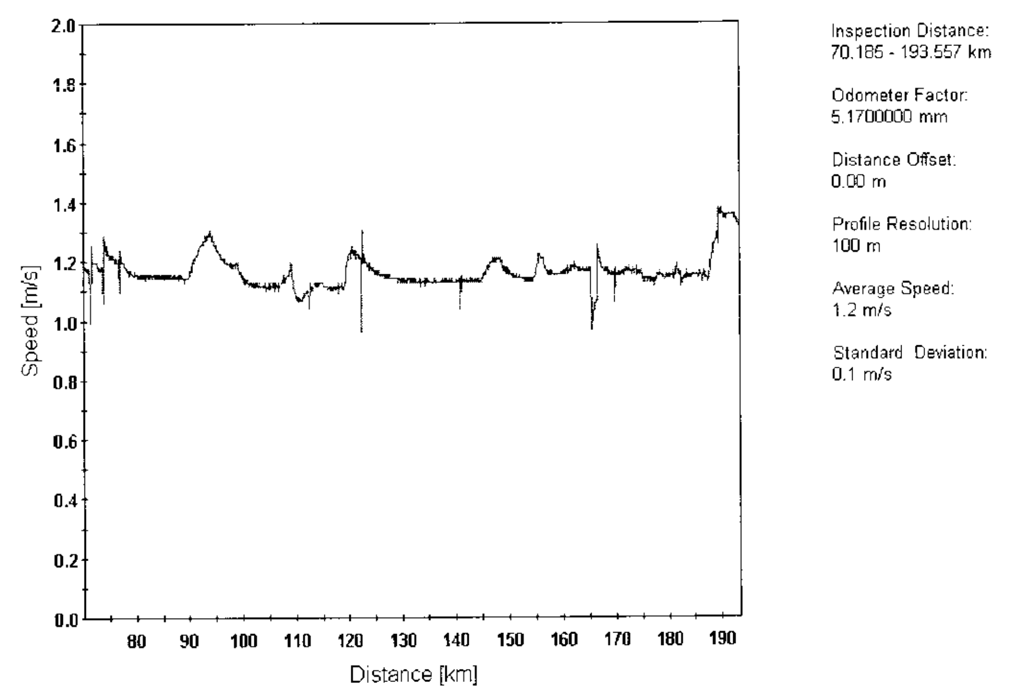
3.5 Speed Profile

During the inspection run DHD105 the average tool speed was approximately 3.61 ft/s with only marginal deviations, i.e. during the inspection the tool was operating in the time-trigger mode providing the optimum axial resolution.



PII Pipetronix UltraScan CD Run DHD105 of 29.06.2005 Printout of 27.09.2005

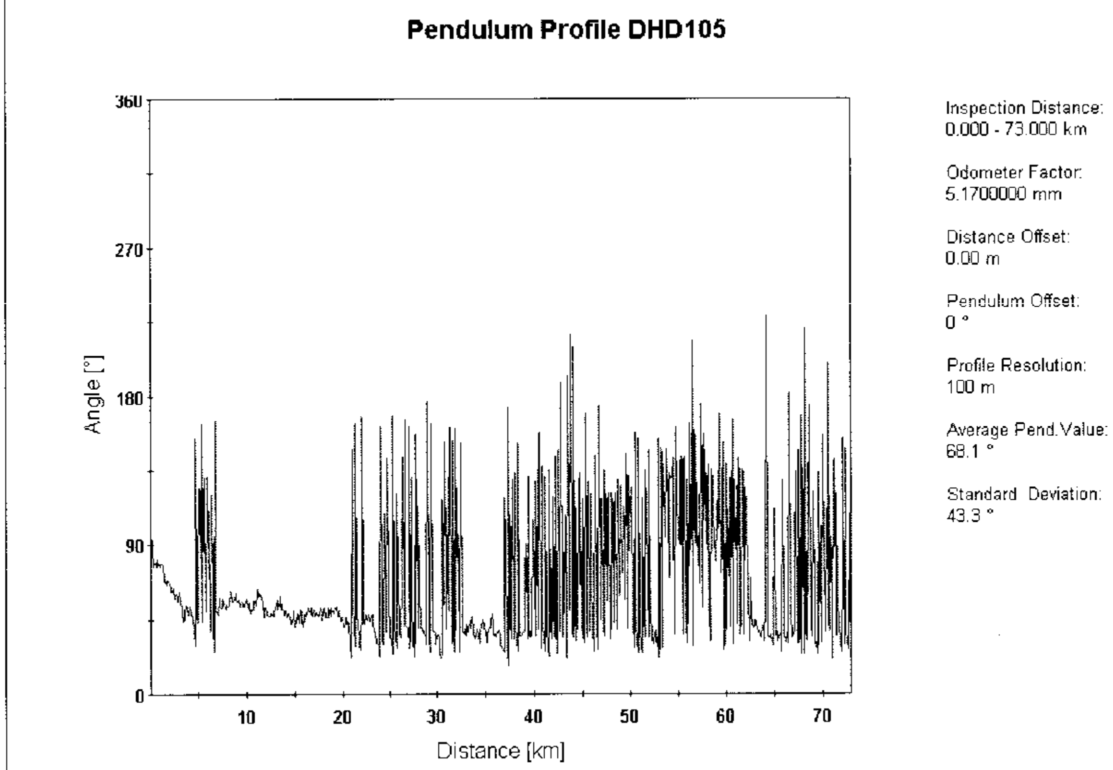
During the inspection run DHD205 the average tool speed was approximately 3.93 ft/s s with only marginal deviations, i.e. during the inspection the tool was operating in the time-trigger mode providing the optimum axial resolution.



PII Pipetronix UltraScan CD Run DHD205 of 02.08.2005 Printout of 27.09.2005

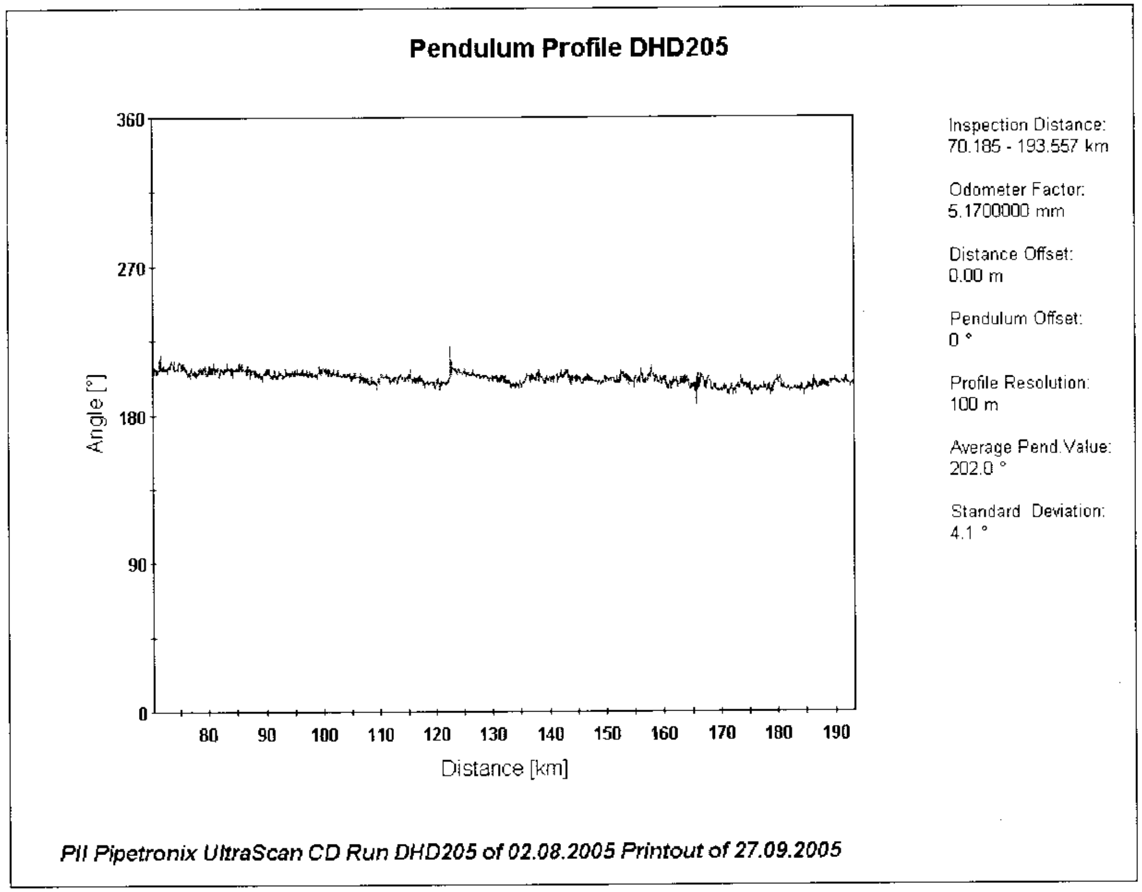
3.6 Pendulum Profile

The pendulum profile shows the rotational movement of the pig during the inspection run. For the inspection run DHD105 the mean deviations are ±43° as can be seen from the attached pendulum profile.



PII Pipetronix UltraScan CD Run DHD105 of 29.06.2005 Printout of 27.09.2005

For the inspection run DHD205 the mean deviations are ±4° as can be seen from the attached pendulum profile.



4. Documentation of Results

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4.1 Evaluation Procedure

The UltraScan CD data collected during the pig run was systematically evaluated in the PII Pipetronix GmbH Data Analysis Department. The individual results are enclosed in the Appendix of this report. Refer to Appendix for the "Features List", the " Detailed Feature Description", the "Verified Features", the "Marker List" and the "Pipebook".
In order to achieve the required quality of the inspection results, the evaluation of the collected UltraScan CD data was performed during the following five phases:

Phase 1: Data Handover from the Workshop

Step	Activity/Result
integration within the management of the analysis department	- determination of the project leader - scheduling of the project
handover meeting	handover report
familiarising of the project leader	preparation of the work folder

Phase 2: Preparation of Data Analysis

Step	Activity/Result
data viewing	- automatic check of the data for completeness and quality as well as of the pig run parameters (speed, pendulum, coupling check)
data pre-processing and DAT tape production	- automatic data pre-processing: downloading and sorting the raw data from DAT tapes or hard disk, creation of areas considering client-specific and run-specific parameters
database generation	- automatic generation of the database for all areas created during pre-processing on the database server
backup copies	- creating backups of the raw data as well as of the pre-processed data
evaluation criteria	- selection of evaluation criteria - determination of documenting criteria together with the customer
pipebook	- editing of the automatically created pipebook - comparison with the client's distance data
marker list	- editing of the automatically created marker list - inclusion of installations found

Phase 3: Main Data Analysis

Step	Activity/Result
selection list	creating a list of indications to be analysed
classification of indications	analysis carried out on computer workstations based on the selection list
feature list editing	- automatic generation of the features list as a database query based on the previously defined selection criteria
quality check	- check of the complete feature list for correctness and completeness

Phase 4: Summarising of the Results

Step	Activity/Result
handover of the feature list to the client	- client's selection of the features to be documented in detail - if necessary, meeting with the client
detailed feature description	- creating the documentation (data sheets, pictures) for the features selected by the client
completion of the final report	- creating/correcting all report texts - providing all lists and data sheets - creating the copies for the client
quality check	- check of the complete final report for correctness and completeness

Phase 5: Project Completion

Step	Activity/Result
handover of the final report to the client	- mailing - if required, clarification of handover - if required, meeting with the client
information of the PII accounts department	copy of the covering letter to administration and sales depts.
filing	correct filing of - final report, work folder with work diskettes, ultrasound data

4.2 Data Evaluation Criteria

The data evaluation is performed in two steps. In the first step (coarse evaluation) the thresholds with regard to some special area parameters are set such that the most severe indications are expected to be with a high probability within the corresponding database selection. In the second step (fine evaluation) the remaining areas are evaluated according to the specified requirements.

The following criteria are normally used for area selection:

- Length of area
- Maximum absolute amplitude in the area
- Signal-to-noise ratio (max. amplitude within area relative to the background level)
- Indication overlap (max. geometrical overlap of indications within area)

The values used for the current evaluation are given in the following tables:

Parameter	Coarse Evaluation	Fine Evaluation
Length (in)	3.937	0.984
Min. Value of Maximum Absolute Amplitude (dB)	40	34
Min. Value of Maximum Relative Amplitude (dB)	28	22
Min. Value of Maximum Overlap	24	12

The settings of the fine evaluation are chosen such that the required reference defects - notches ≥0.984 in length and depth 0.039 in - are safely detected.

4.3 Notes on the Features List

The results of the analysis work done by the PII Pipetronix GmbH Data Analysis Department are collected in the Features List (see Appendix A). Appendix A contains a complete features list.

During the off-line data preparation, the ultrasonic indications coming from the same locations (ideally from the same reflector) are combined to defect areas. These areas are indicated in the C-scans by boxes. Such an area is usually related to one individual reflector. In the case of a crack field, for example, with many defects located close together usually one area is generated for the whole field. For each area several parameters like area length, width, overlap, amplitude etc. are derived and stored in a database. These steps are performed automatically using dedicated software.

The subsequent data analysis is performed in such a way that from the whole set of areas only those complying with certain criteria are selected from the database. These areas are then looked at and classified by skilled analysts. Finally, the result of data analysis is summarised in the features list.

The features list normally consists of several sections. One section typically corresponds to a length of approx. 0.93 miles depending on the actual amount of data. Besides its co-ordinates (distance and circumferential position) each feature is identified by a unique ID-number.

The features list contains the following types of indications:

- indications caused by crack fields
- indications caused by crack-like defects
- indications caused by metal loss
- indications caused by installations (useful as 'natural' markers)
- notch-like indications (notch-like indications with the comment *weak* are not included)
- inclusion-like indications with the comment strong
- indications of unknown or ambiguous origin (not decidable)
- indications with the comment strong or striking
- dents, deformations (if detected)
- verified indications (v) and indications documented in detail (d)

An example of the structure of the features list is given in the following table:

Pig Run	Area No.	Pipe No.	LW [°]	Wt [mil]	DuGW [ft]	DdGW [ft]	Distance [ft]	Deg [°]	Length [in]	Est. Depth [%WT]	Rel. Pos.	Rad. Pos.	Type	Comment	
DHD105	01-01234	14.00	71	246.1	2.45	0.02	1.12	67	1.45	< 12.5	bm	e	Notch-Like	sloping	
DHD105	01-04321	18.00	358	246.1	11.20	0.09	3.10	128	2.90	< 12.5	aw	i	Crack-like		d
DHD105	01-03123	20.00	120	246.1	6.09	5.12	3.09	33	5.67	< 12.5	bm	e	Notch-Like		

The following abbreviations are used:

- Pig Run — Inspection run
- AreaNo. — Area ID
- PipeNo. — Number of pipe joint
- LW — Circumferential position of longitudinal weld
- Wt — Wall thickness of the pipe joint in mil
- DuGW — Distance to upstream girth weld in ft
- DdGW — Distance to downstream girth weld in ft
- Distance — Distance to left area start in ft
- Deg — Circumferential position of center of area in degrees
- Length — Length of area in in
- Est. Depth — Estimated depth of defect in % WT
- Rel. Pos. — Relative position of area
  - bm — in **b**ase **m**aterial
  - aw — **a**djoining **w**eld
  - iw — **i**n longitudinal **w**eld
  - nd — **n**ot **d**ecidable

- Rad. Pos. — Radial position of indication
  external
  internal
  mid-wall
  not decidable

- Type — Type of indication
  crack field
  crack-like
  not decidable
  metal loss
  notch-like
  inclusion-like
  installation
  geometry-related

- Comment — In the comment column, several abbreviations are used in order to characterise the indication with regard to:

  - ***general impression***
    strong — strong indication
    weak — weak indication
    striking — striking indication
  - ***shape***
    sloping — sloping indication
    curved — curved indication
    intermittent — intermittent indication

  - ***location***
    at GW — **at G**irth **W**eld
    near GW — **near G**irth **W**eld
    distance to girth weld below approx. 15.74 in
    Pipe with Incl.I — **Pipe with I**nclusions/Laminations

  The features documented in detail are indicated in the comment by a "d", the verified features are marked by "v".

4.4 Notes on the Detailed Feature Description

In agreement with the client, some of these features were documented in detail and marked by a "d" in the selected features list.

The detailed description includes the following items for every feature so marked:

- Data sheet with detailed information about location of defect, location of the pipe joint concerned and a comment.

- *Coloured amplitude C-scan*
  The colours indicate the amplitudes of the ultrasonic signals projected on the pipe surface. Below the C-scan of the crack detection data the wall thickness data resulting from the straight sensors are displayed as C-scan as well.
  Typical length of displayed pipe section: approx. 3.93 ft.
  Typical width of displayed pipe section: 360° (entire circumference)
  In some cases, compressed C-scans are provided showing, for example, the whole pipe joint thus allowing for a more context-related visualisation of the defect area.

- *Coloured overlap - C-scan*
  Here, the colours encode the overlap of indications which is a (filtered) measure of basically how many sensors have detected a reflector at the same position. Normally, the overlap C-scan is magnified compared to the amplitude C-scan.

- *One or more B-scans*
  The B-scans showing the main indications within the defect area are documented. One picture may show up to three B-scans as recorded by adjacent sensors. If available and useful, B-scans from both inspection sides are included. Below the B-scans the sensor number as well as its angular position are indicated. The setting of the amplitude range may vary. It is adjusted such that the main indications become clearly visible in the colour copies. The approximate position of the external (internal) pipe surface is shown at the right border line of the B-scans by red (blue) dashes. In the B-scans, the position of the internal surface is indicated by a black line within the entrance range of the signals.

Note: The distance given at the axes in the C- and B-scans is the distance between the start of area and the nearest girth weld. Positive (negative) values indicate that the reference girth weld is upstream (downstream) relative to the defect area.

In the C-scans, all areas of interest are indicated by rectangular boxes. The actual area is usually located in the centre and marked by a red-coloured border. Area position data refer to the left centre of the area box. The symbols visible at the left side of the area box are used for recognition of the area classification. The following symbols are used:

∗ crack-like or crack field
⊕ metal loss (corrosion)
\+ not decidable
✡ notch-like
◊ not in selection list
◆ inclusion-like
o geometry
• installation
x irrelevant

At the right side of the pictures some information with regard to area parameters and area location can be found:

Area

• Area Number	Area ID
• Distance	Distance of area start in ft
• CP	Circumferential position of area (0° corresponds to 12 o'clock position)
• RP	Radial position of area
• DtoGW u/d	Distance to upstream/downstream girth weld in ft
• DtoLW	Distance from centre of area to longitudinal weld in °/ft
• DtoMrk u/d	Distance to upstream/downstream marker in ft
• Length	Length of area in in
• Width	Width of area in in
• Amplitude	Maximum amplitude within area in dB
• Background	Mean background level within area in dB
• Overlap	Maximum overlap within area
• Pipe Number	Pipe number
• Distance	Distance of upstream girth weld in ft
• WT	Average wall thickness in mil

Scan

• Distance	Distance of closest girthweld (blanc rhombus) in ft
• V	Surveying velocity in ft/s
• Comp. Factor	Compression of the C-scan or B-scan

Note: All angular positions are given clockwise, i.e. the angle increases in clockwise direction when looking downstream.

4.5 Notes on the Verified Features

Based on the results of the Final Report several verification digs were carried out by the client. The results of the verification digs available so far together with the data analysis predictions are summarized in Appendix C.

The verification results show that notch-like and crack-like indications were hardly to discriminate. On account of this, a depth sizing of all notch-like indications was carried out.

4.6 Notes on the Marker List

The marker list (see Appendix D) contains the following information:

Example Marker List

No.	Marker ID.	Pipe No.	DdGW [ft]	Odometer Distance [ft]	Client Distance	Pig Run	Comment
1	Installation	112.00	1.30	77.07	1.083	DHD105	
2	1	277.00	20.90	887.20	2.858	DHD105	
3	2	571.00	12.19	2651.15	5.501	DHD105	

- No. — Continuous number of marker
- Marker ID. — Client's ID number of marker
- Pipe No. — Client's pipe number (corresponds to PII pipe number)
- DdGW — Distance of the marker to the downstream girth weld in ft
- Odometer Distance — Odometer distance in ft
- Client Distance — Client's distance
- Pig Run — Inspection run during which the marker was set
- Comment — Additional information

Installations like valves, T-pieces, stopples, sleeves etc. with known locations can also be used as markers. As far as available from the data they are included in the marker list. Additionally, any pipe joint with known location, e.g. from former digs, can be used as reference point if necessary.

If digging leads to a wrong pipe joint, the following procedure will be successful:

- Measure length of wrong pipe joint.
- Measure wall thickness of wrong pipe joint as well as of the two adjacent joints.
- Determine position of longitudinal weld for the pipe joint concerned as well as for the two adjacent joints (o'clock position when looking downstream).
- Provide this information to PII Pipetronix.

With this information PII Pipetronix can normally locate the right pipe-joint relative to the wrong one.

Note: Knowing the length as well as the wall thickness of three subsequent pipe joints, the corresponding sequence may often be identified from the pipebook.

4.6 Notes on the Statistics

The statistic on the defect distribution is presented in Appendix E.

The figure shows the defect distribution number of detected defects vs. distance as obtained for indications associated with crack colonies (cf), crack-like (cl) features, not decidable (nd) features and notch-like features (nl). Verified features are not considered.

4.7 Notes on the Pipebook

The Pipebook (see Appendix F) lists all pipe joints in consecutive order.

The following table gives an example of the structure of the pipebook:

PipeNo.	WT [mil]	PipeStart [ft]	PipeEnd [ft]	Length [ft]	LW [deg]	Comment
3.00		54.42	55.56	1.14		Flange
4.00	413.4	55.56	58.75	3.19		Valve
5.00	374.0	58.75	65.06	6.32		

- Pipe No. — Number of the pipe joint
- WT — Average wall thickness of the pipe joint in mil
- PipeStart — Distance to start of pipe joint in ft
- PipeEnd — Distance to end of pipe joint in ft
- Length — Length of pipe joint in ft
- LW — Circumferential position of long. weld in degree
- Comment — Comment (e.g. installations)

The pipe number is used with two decimal places. This allows for future corrections, for example in case of repair, without completely changing the subsequent numbering.

5. Summary

The 121.8 mi x 12" Dixie propane pipeline from Hattisburg Station to Demopolis Station was inspected in July and August 2005 using the crack detection tool UltraScan CD in order to find axial crack-like defects having minimum length >0.984 in and minimum depth >0.039 in. The main results of the inspections can be summarised as follows:

- After successful completion of the inspection run, data analysis was carried out by the PII Pipetronix GmbH data analysis department in Karlsruhe-Stutensee, Germany.
- In total 14721 features were found by the data analysis:
- 7 crack fields
  - 4 crack fields – estimated depth 12.5-25% WT
  - 3 crack fields – estimated depth <12.5% WT
- 4004 crack-like features
  - 6 crack-like features – estimated depth >40% WT
  - 505 crack-like features – estimated depth 25-40% WT
  - 2520 crack-like features – estimated depth 12.5-25% WT
  - 973 crack-like features – estimated depth <12.5% WT
- 10344 notch-like features
  - 63 notch-like features – estimated depth 25-40% WT
  - 1494 notch-like features – estimated depth 12.5-25% WT
  - 8787 notch-like features – estimated depth <12.5% WT
- 82 not decidable features
- 99 inclusion-like features
- 92 geometry-related features
- 91 installations
- Due to the small wall thickness features with the estimated depth <12.5% WT are below the specified detection threshold (<0.039 in).
- Due to the different geometrical circumstances at ERW welds, indications can be caused by the edge of a not completely ground "weld cap" or a notch-like indication. In these cases the indications are classified with the additional comment 'probably indication from weld'.
- Considering the results of the verification digs, the following differences to the first issue of the notch-like features can occur:
  - change of the length from the notch-like features
  - in some cases, features with the comment 'probably indication from weld' were reclassified with the comment 'possibly weld defect'
  - in some cases, features with the comment 'intermittent' were divided into two features
- The depth estimation was carried out for all crack-like and notch-like indications independing of their position in the seam weld